OPERATING MANUAL

Alco
DIESEL-ELECTRIC

GE

1600 HP FREIGHT-PASSENGER LOCOMOTIVE

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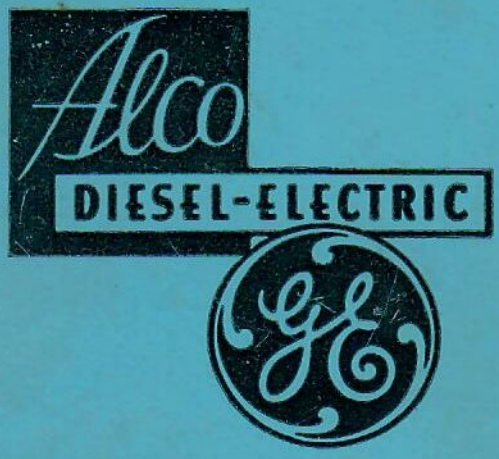
AMERICAN LOCOMOTIVE COMPANY
GENERAL ELECTRIC COMPANY
Schenectady, N. Y.

OPERATING MANUAL



1600 HP FREIGHT-PASSENGER LOCOMOTIVE

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OPERATING MANUAL

TP-402

FOR

1600 HP DIESEL-ELECTRIC ROAD FREIGHT-PASSENGER LOCOMOTIVE

●

This manual covers basic operating instructions to assist the engineman in the efficient handling of the 1600 HP Road Freight-Passenger locomotive models: **FA-2, FB-2, FPA-2** and **FPB-2.**

Descriptive information pertaining to the most commonly used "specialties" is contained herein and defined with the phrase (if used). The manual is written so as to be complete for locomotives with or without the specialty equipment.

The information furnished is based on construction as of date material was compiled.

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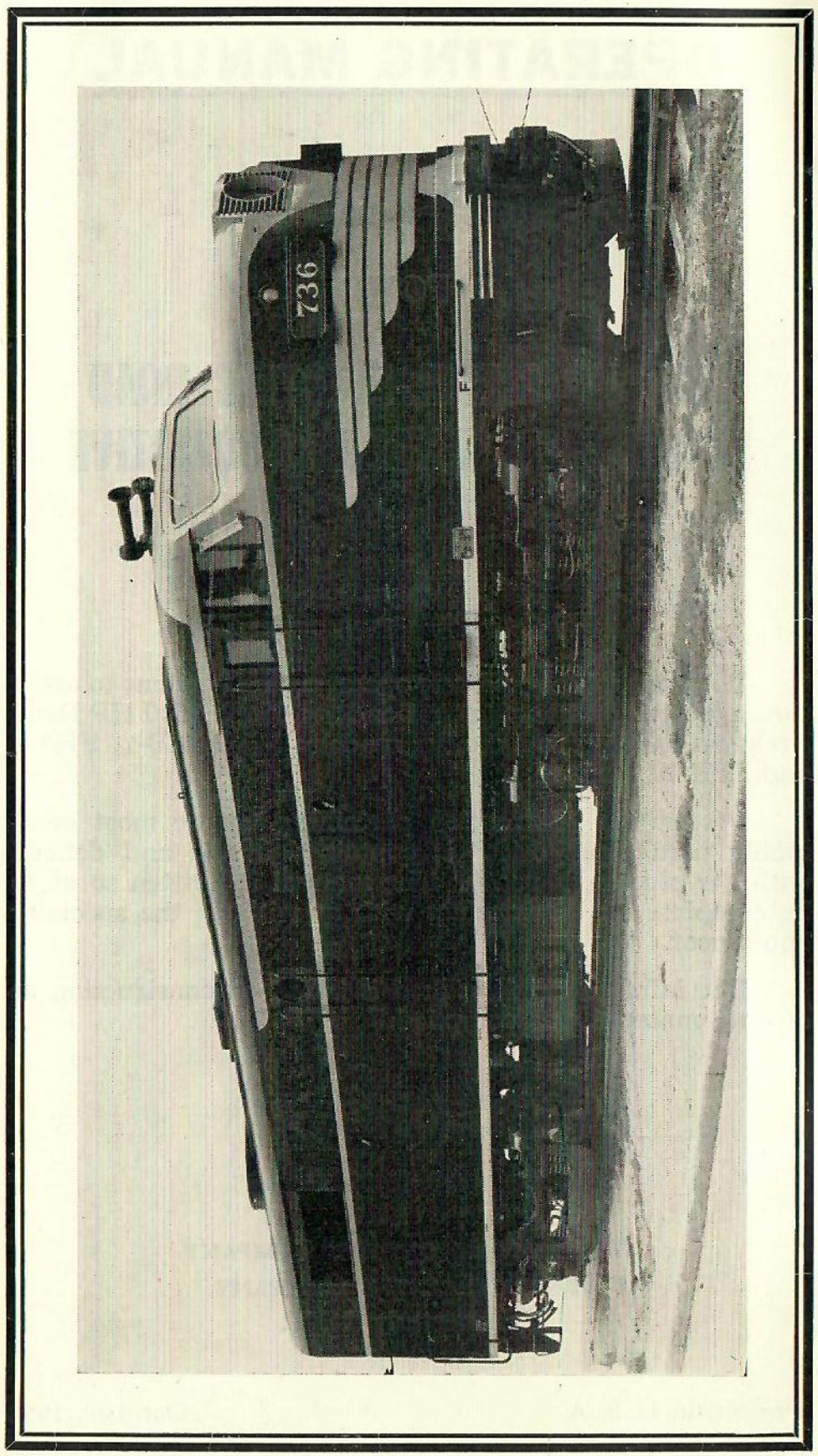

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IMPORTANT

THIS BOOK IS DISTRIBUTED FOR USE OF INSTRUCTORS ASSIST THEM IN THE TRAINING OF CREWS IN THE PROP OPERATION OF DIESEL FREIGHT LOCOMOTIVES.

INSTRUCTIONS THEREIN THAT CONFLICT WITH P. R. R. INSTRUCTIONS OR RULES SHALL BE DISREGARDED.

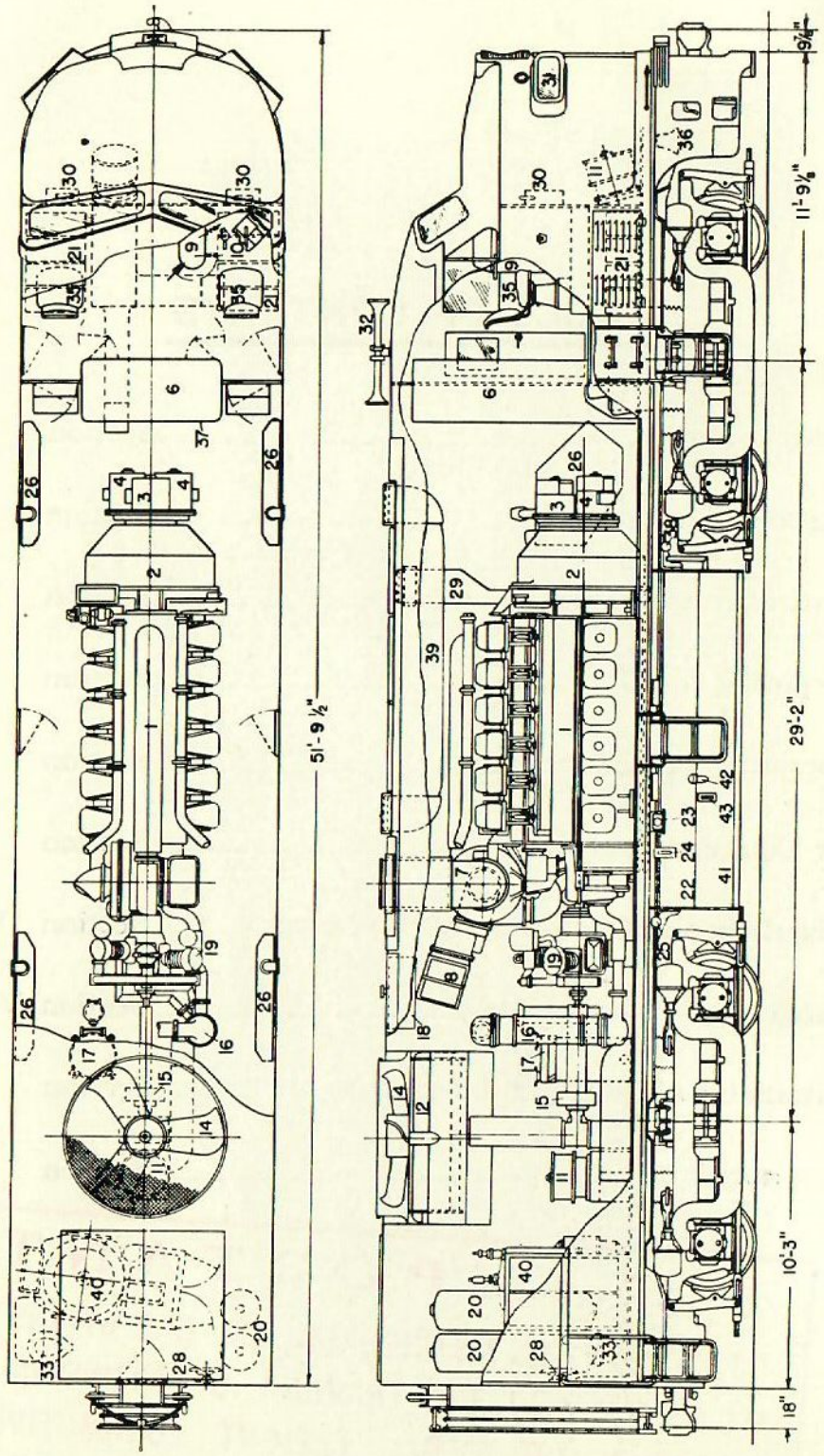
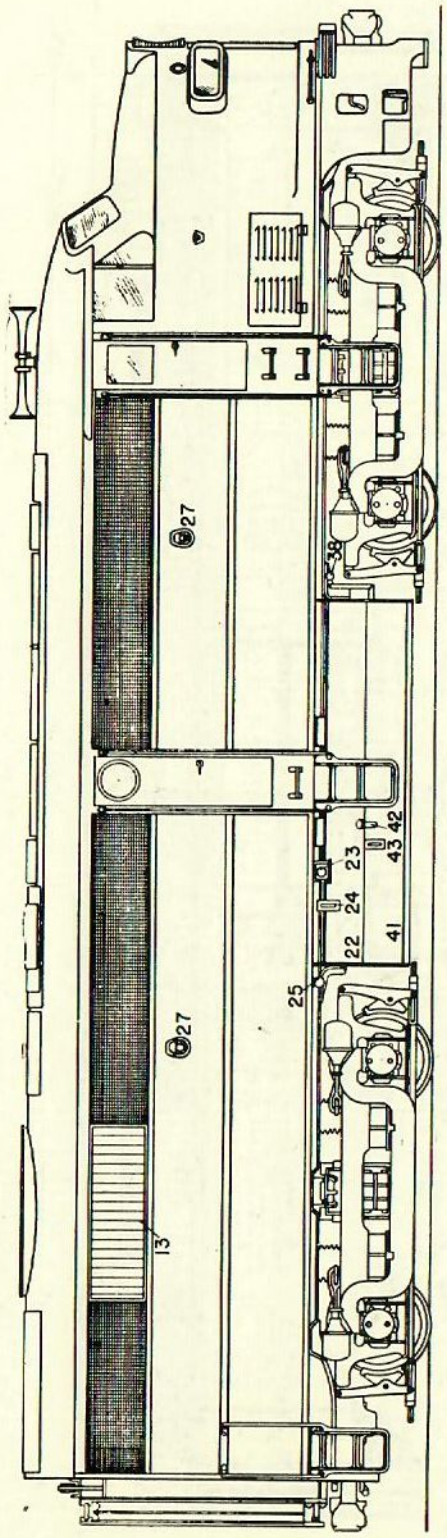


Fig. 1 — Part I

LOCATION OF APPARATUS "A" UNIT



1- ENGINE
2- MAIN GENERATOR
3- EXCITER
4- AUXILIARY GENERATOR
5- TRACTION MOTORS
6- CONTACTOR COMPARTMENT
7- TURBOSUPERCHARGER
8- TURBOSUPERCHARGER FILTERS & SILENCERS
9- CONTROL STAND
10- BRAKE VALVES
11- TRACTION MOTOR BLOWERS
12- RADIATORS
13- RADIATOR SHUTTERS
14- RADIATOR FAN
15- RADIATOR FAN CLUTCH
16- LUBRICATING OIL COOLER
17- LUBRICATING OIL FILTER
18- ENGINE WATER TANK
19- AIR COMPRESSOR
20- MAIN AIR RESERVOIRS
21- BATTERIES
22- FUEL TANK
23- FUEL TANK FILLING CONNECTION
24- FUEL TANK GAUGE
25- EMERGENCY FUEL CUT OFF
26- SANDBOXES
27- SANDBOX FILLING HOLES
28- HAND BRAKE
29- GENERATOR AIR DUCT
30- CAB HEATER
31- NUMBER BOXES
32- HORNS
33- TOILET
34- HEADLIGHT - FIXED
35- SEATS
36- BELL
37- ENGINE CONTROL PANEL
38- BATTERY CHARGING RECEPTACLE
39- DYNAMIC BRAKE GRIDS & BLOWERS (MODIFICATION)
40- STEAM GENERATOR (MODIFICATION)
41- WATER TANK (MODIFICATION)
42- WATER TANK FILLING CONNECTION (MODIFICATION)
43- WATER TANK GAUGE (MODIFICATION)
44- HEADLIGHT - OSCILLATING (MODIFICATION)

Fig. 1 — Part II

LOCATION OF APPARATUS "A" UNIT

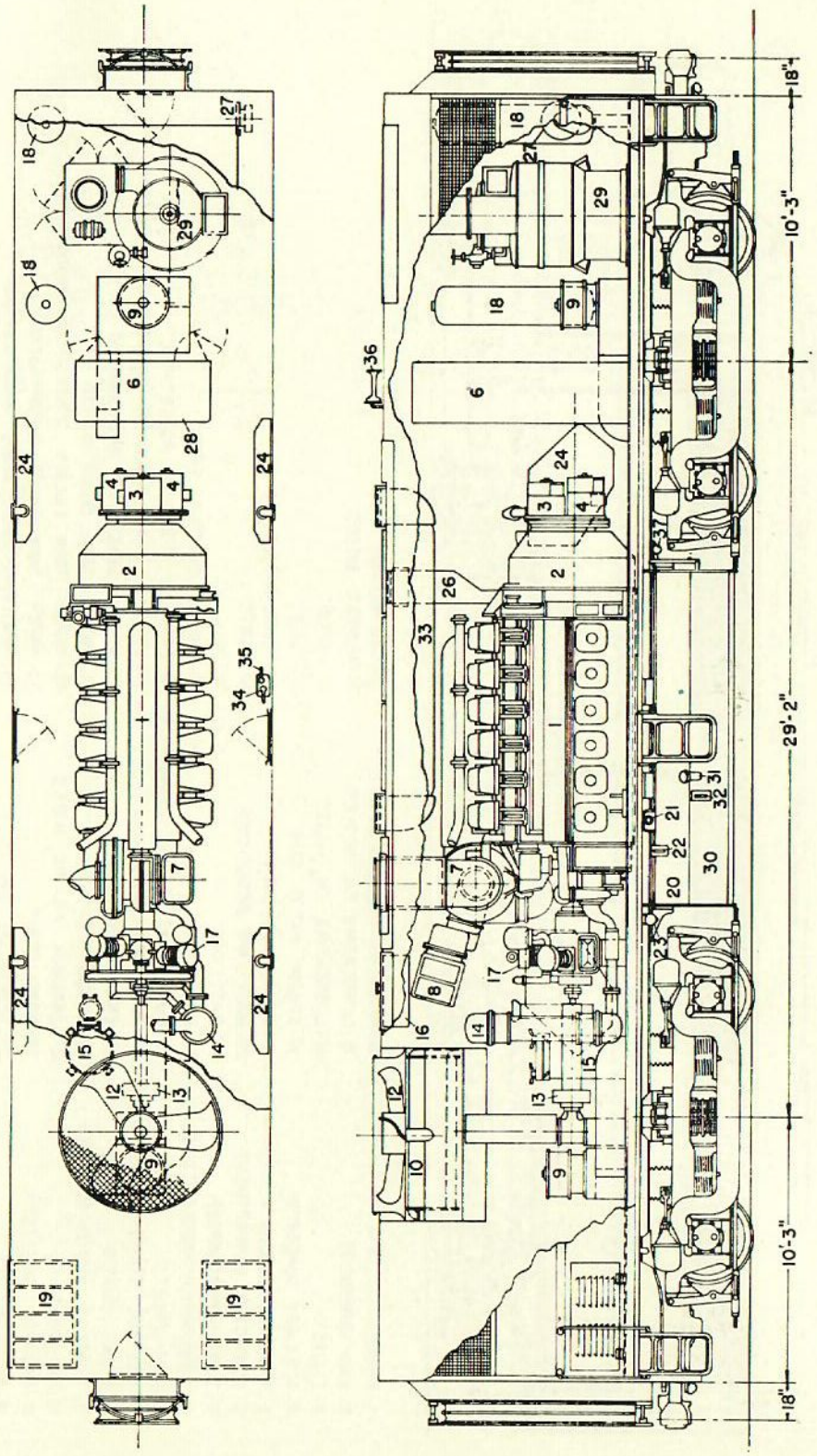
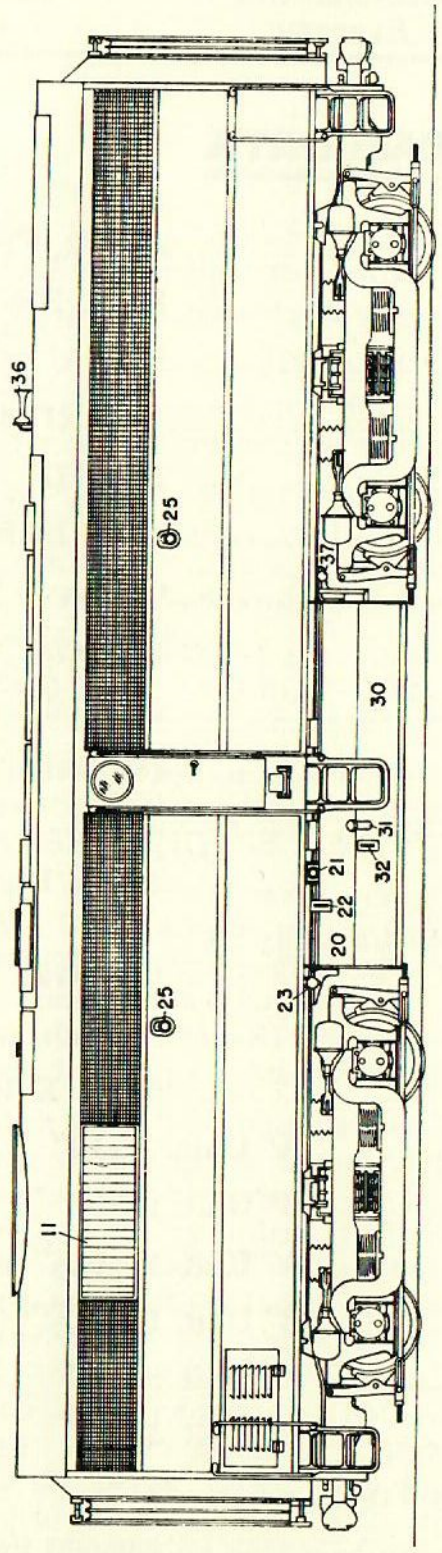


Fig. 2 — Part I
LOCATION OF APPARATUS "B" UNIT



1 - ENGINE
2 - MAIN GENERATOR
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4 - AUXILIARY GENERATORS
5 - TRACTION MOTORS
6 - CONTACTOR COMPARTMENT
7 - TURBOSUPERCHARGER
8 - TURBOSUPERCHARGER FILTERS & SILENCERS
9 - TRACTION MOTOR BLOWERS
10 - RADIATORS
11 - RADIATOR SHUTTERS
12 - RADIATOR FAN
13 - RADIATOR FAN CLUTCH
14 - LUBRICATING OIL COOLER
15 - LUBRICATING OIL FILTERS
16 - ENGINE WATER TANK
17 - AIR COMPRESSOR
18 - MAIN AIR RESERVOIRS
19 - BATTERIES
20 - FUEL TANK
21 - FUEL TANK FILLING CONNECTION
22 - FUEL TANK GAUGE
23 - EMERGENCY FUEL CUT OFF
24 - SANDBOXES
25 - SANDBOX FILLING HOLES
26 - GENERATOR AIR DUCT
27 - HAND BRAKE
28 - ENGINE CONTROL PANEL
29 - STEAM GENERATOR (MOD.)
30 - WATER TANK (MOD.)
31 - WATER TANK FILLING CONN. (MOD.)
32 - WATER TANK GAUGE (MOD.)
33 - DYNAMIC BRAKE GRIDS & BLOWERS (MOD.)
34 - HOSTLER CONTROL (MOD.)
35 - BRAKE VALVE (MOD.)
36 - HORN (MOD.)
37 - BATTERY CHARGING RECEPTACLE

Fig. 2 — Part II
LOCATION OF APPARATUS "B" UNIT

ing system is used; the cooling water flows successively through the engine, the radiators and the lubricating oil cooler and is circulated by an engine driven centrifugal pump. Lubricating oil is cooled by the water in the heat exchanger and the water by fan cooled radiators. Thermostatically controlled radiator shutters and fan maintain desired engine temperature automatically.

2. TRACTION AND AUXILIARY GENERATORS

The traction generator is direct-connected to the Diesel engine crankshaft while the auxiliary generator, amplidyne exciter and traction motor blower generator are gear driven from the generator shaft. The traction generator produces direct current for operation of the traction motors and the amplidyne exciter furnishes excitation for the traction generator. The traction motor blower generator furnishes current to the front and rear truck traction motor blowers. These blowers provide ventilating air to cool the traction motors. The auxiliary generator furnishes current for battery charging and low voltage circuits for lighting, control, fuel pump and excitation.

3. TRACTION MOTORS

Four traction motors are used on a locomotive unit. Each motor is supported by axle suspension bearings and a spring nest mounted on the truck frame.

Shrunk onto the motor armature shaft is a pinion which meshes with a drive gear pressed onto the wheel axle. The gear ratio between the pinion and drive gear determines the maximum locomotive speed and is expressed in two figures such as "74/18". The first number indicates the number of teeth on the driven gear and the second number indicates the number of teeth on the pinion.

The traction motors are connected either in series-parallel or parallel depending upon the speed of the locomotive. During acceleration the selector handle movement controls the following motor connections:

No. 1	Series-Parallel
No. 2	Series-Parallel Shunted Fields
No. 3	Parallel
No. 4	Parallel Shunted Fields

The motor connections take place in reverse order when a train is decelerating with power on.

"Transition" is the changing of traction motor connections and is controlled by the movement of the selector handle. Two methods of transition are in use, manual or automatic.

The forward and reverse movement of the locomotive is controlled by the positioning of the reverser which, when moved from forward to reverse position by the reverse handle at the engineman's position, changes the direction of the current through the traction motor fields.

4. AUXILIARY EQUIPMENT

On road freight-passenger locomotives, an extension shaft from the diesel engine drives the air compressor through a flexible coupling. A shaft from the air compressor then drives the radiator fan through an eddy current clutch and right angle gear box.

5. DYNAMIC BRAKING (If Used)

The dynamic brake is a means by which the traction motors are used to produce braking instead of pulling effort. The motors are reconnected as generators and the power produced by them is dissipated as heat by fan blown resistors. This brake is used principally on grades, though it may also be used for slowdowns. The resistor assembly is located in the engine room above the diesel engine.

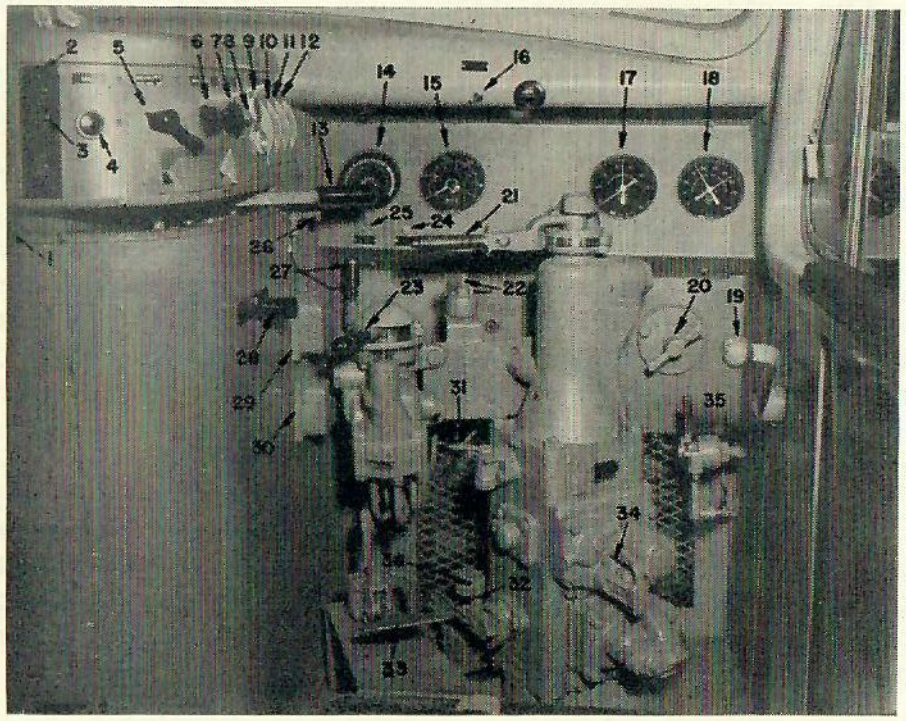

Fig. 3 — ENGINEMAN'S POSITION

1. Selector Handle
2. Hot Engine Light
3. Low Lube Oil Pressure Light
4. Call Button
5. Headlight Switch
6. Cab Heater Control
7. Gauge Light Control
8. Defroster Switch
9. Emergency Engine Stop-Run Button
10. Control Circuit Breaker
11. Generator Field Circuit Breaker
12. Fuel Pump Circuit Breaker
13. Throttle Handle
14. Load Indicator
15. Speed Indicator
16. Order Light Switch
17. Brake Cylinder and Brake Pipe Air Gauge
18. Main and Equalizing Reservoir Air Gauge
19. Window Handle
20. Rotair Valve
21. Automatic Brake Valve Handle
22. Bell Valve
23. Independent Brake Valve Handle
24. Wheel Slip Warning Light
25. Dynamic Brake Warning Light
26. Windshield Wiper Valve
27. Safety Control Whistle
28. Reverse Handle
29. Alarm Buzzer — Low Oil pressure, hot engine, ground relay, traction motor blowers off, dynamic brake warning (if used), boiler flame out (if used)
30. Wheel Slip Warning Buzzer
31. Selector Cock
32. Double Heading Cock
33. Safety Control Pedal
34. Safety Control Cutout Cock
35. Sander Valve
36. Feed Valve

III CONTROLLER OPERATING HANDLES

A. THROTTLE HANDLE

1. Has an IDLE position and eight running notches. Its position is shown by indicator above handle.
   (a) Advance Throttle Handle into each succeeding notch by moving handle slightly toward IDLE and then move into the succeeding notch. This action releases the latch which prevents rapid notching or accidental opening.
   (b) The Throttle Handle can be returned to IDLE as rapidly as desired.

B. SELECTOR HANDLE

1. Has an OFF position with four MOTORING positions to the left and (if used) a BRAKING range to the right. Its position is shown by indicator at top of controller.
   (a) Handle in OFF position disconnects traction motors, power and braking circuits.
   (b) Handle in MOTORING positions makes the following traction motor connections:
   No. 1—Series-Parallel.
   No. 2—Series-Parallel Shunted Fields.
   No. 3—Parallel.
   No. 4—Parallel Shunted Fields.
   (c) Handle in BRAKING range provides control of dynamic braking. If locomotive is not equipped with dynamic braking a stop on the controller prevents movement of the handle into the braking range.

C. REVERSE HANDLE

1. Has three positions, FORWARD, OFF and REVERSE for selecting the desired direction of locomotive movement.

D. MECHANICAL INTERLOCKING BETWEEN HANDLES

1. THROTTLE HANDLE

(a) Can be moved from IDLE position only with Selector Handle in 1, 2, 3, or 4, and Reverse Handle installed.

2. SELECTOR HANDLE

(a) Can be moved from OFF to the No. 1 position regardless of Reverse Handle position.

(b) Can be moved to position No. 2, No. 3 or No. 4 only when Reverse Handle is in FORWARD or REVERSE.

(c) On units equipped with dynamic braking the Selector Handle can be moved into the Braking Range only when Reverse Handle is in FORWARD or REVERSE and Throttle Handle is in IDLE.

3. REVERSE HANDLE

(a) Can be moved only when Throttle Handle is in IDLE, and with the Selector Handle in any MOTORING position.

(b) Can be installed or removed only when in OFF position.

IV PREPARING FOR OPERATION

A. BEFORE BOARDING

1. Check fuel supply on each unit.
2. Check steam generator water supply (if used).
3. Check Emergency Fuel Shut Off valve located at rear end of fuel tank left side. If closed, reset manually by pulling up on the valve stem and reset the crutch which holds the valve open.
4. Check proper positioning of angle cocks and shutoff valves, also for liquids leaking from external piping.
5. Check for loose or dragging parts.

B. IN CAB

1. "A" UNITS

(a) Close battery switch.

(b) If lights are needed, close necessary circuit breakers on Control Compartment Panel and toggle switches on Engineman's Control Stand.

(c) Move Throttle Handle to Idle.

(d) Move Reverse and Selector Handles to OFF.

2. "B" UNITS

(a) Close battery switch.

(b) If lights are needed, close necessary circuit breakers on Control Compartment Panel and toggle switches.

(c) Place Controller Handle at Hostler's Station in OFF position (If Used).

(d) Place Reverse Handle in OFF position (If Used).

3. "A" and "B" UNITS

(a) The Ground Relay Cutout Switch must be closed and the Ground Relay Indicator Target must not show red. If tripped, see GROUND RELAY instructions.

(b) The Traction Motor Cutout Switch (if used) should indicate "All In". If in any other position see TRACTION MOTOR CUTOUT SWITCH instructions.

C. IN ENGINE ROOM

1. Inspect to see that no rags, tools, lanterns, etc., are near shafts, or other moving parts or electric apparatus. Never use waste on the locomotive.

2. Lubricating Oil Drain Valves must be closed.

3. Check the Diesel engine lubricating oil level. Bayonet gauge should show oil between the high and low marks.

4. Cooling Water Drain Valve must be closed.

5. Check the quantity of water in the engine cooling water system. The sight glass attached to the water expansion tank should show water at all times.

6. The engine governor operates under hydraulic oil pressure. The reservoir of oil in the governor base is equipped with two sight glasses. The oil level, with fuel booster pump running, should be between line on lower sight glass and line on upper sight glass.

7. Place handle on the Duplex Fuel Oil Filter to either the horizontal or vertical position, preferably horizontal.

8. The Radiator Fan Control Switch should be in "automatic" position and the locking pin on each shutter drive rod link removed. Examine shutter operating linkage for freedom of movement. If operated on manual control, close observance of water temperature should be made. See ENGINE WATER TEMPERATURE CONTROL.

9. Check to insure that the Air Compressor Governor and Unloader Cut Out Cocks are OPEN. These cocks are located in pipes leading to the respective pieces of equipment mounted on a column to the rear of the air compressor.

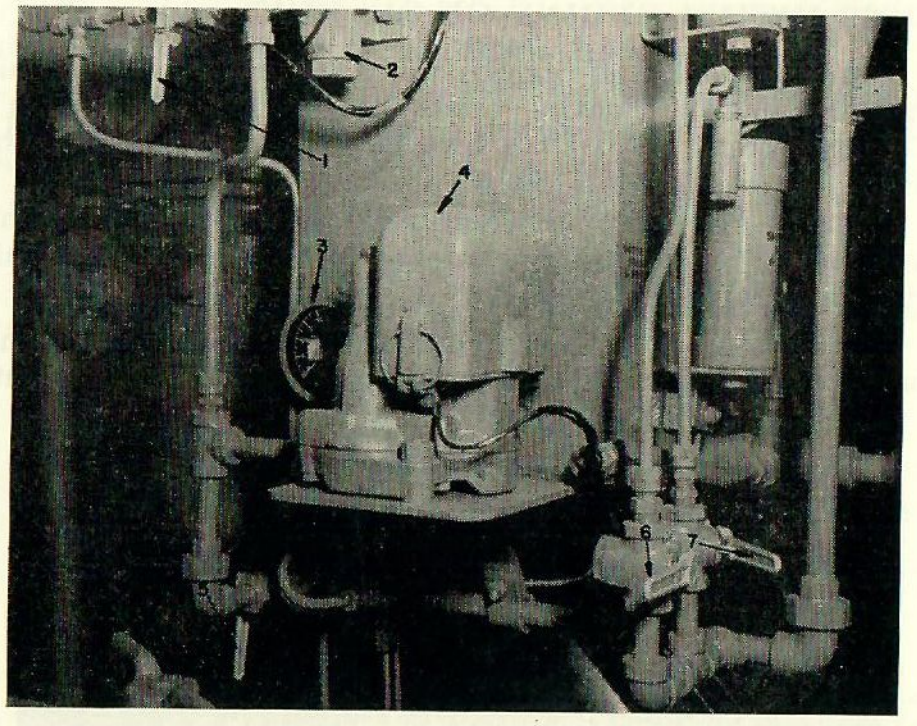

Fig. 4 — AIR COMPRESSOR GOVERNOR CONTROLS

1. Cutout Cock—Magnet Valve to Compressor
2. Magnet Valve
3. Main Air Reservoir Gauge
4. Air Compressor Governor
5. Cutout Cock—Governor and Magnet Valve
6. Cutout Cock—Main Reservoir to Cooling Water Control Panel
7. Cutout Cock—Main Reservoir to Shutter Motors

10. Diesel Engine Turning Gear must be disengaged and locked. This is located at the air compressor end of of the engine and mounted directly above the engine crankshaft extension.

11. The Diesel engine Overspeed Reset Button must be IN.

12. Check the air compressor oil level with the engine shut down. Maintain the oil level at the ful mark on the bayonet gauge.

13. Check sand supply.

D. STARTING ENGINE ON "A" UNIT

Starting the Diesel engine on an "A" unit involves circuit breakers on the Control Compartment and Engineman's Control Stand, the Battery Switch and the Engine Control Switch.

The main group of circuit breakers is located on the front of the Control Compartment which forms the rear wall of the operating cab.

The second group of circuit breakers is located at the top of the Engineman's Control Stand to the left of his seat.

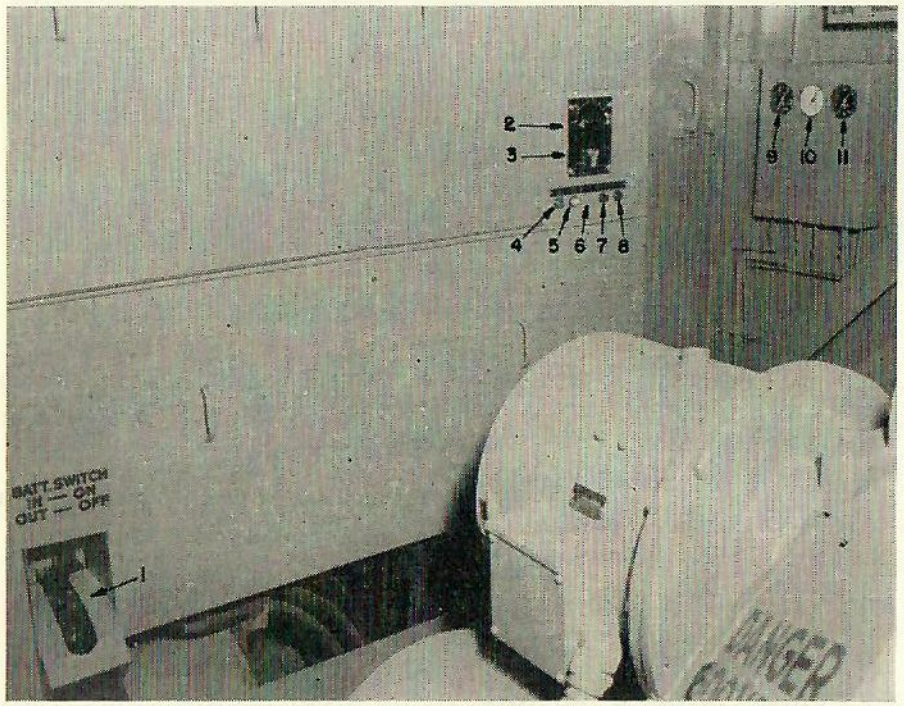

Fig. 5 — BACK WALL OF CONTROL COMPARTMENT

1. Battery Switch
2. Engine Control Switch
3. Engine Start Switch
4. Exhauster Running
5. Ground or Blowers Stopped
6. Boiler Flame Out (If Used)
7. Low Lube Oil
8. Hot Engine
9. Fuel Oil Pressure
10. Lube Oil Pressure
11. Turbo Air Pressure

The battery switch is located in the back wall (engine room side) of control compartment, in lower left corner.

The engine control switch is located in the back wall of control compartment to the right hand side.

All control circuits are protected by circuit breakers. The only fuses on the unit are those on the steam generator panel (if used).

To Start Engine:

1. Close Battery Switch.
2. Place Throttle Handle in IDLE, Selector and Reverse handles in OFF.
3. Close all circuit breakers on the Control Compartment Panel.
4. Close the Control and Fuel Pump Breakers and push Run button of Emergency Engine Stop Switch on Engineman's Control Stand.
5. Allow pressure to build up to 35-45 psi on Fuel Oil Pressure Gauge mounted on gauge panel on wall to right of Engine Control Switch.
6. Turn Engine Control Switch to IDLE. Low oil pressure green light will light and alarm bell will ring until engine is started and oil pressure is raised to 7 psi or higher.
7. Turn Start Switch to the left to crank engine. Hold in this position while cranking the engine until oil pressure shows on gauge, alarm stops and green light goes out. WARNING: Releasing the Start Switch before the green light goes out will stop the engine. If this happens, engine must be allowed to come to a complete STOP before repeating the above starting procedure.
8. Do not discharge battery by repeated attempts to crank. If the first two or three attempts are not successful, recheck complete starting preparation.
9. Check Lubricating Oil Pressure Gauge on Gauge Panel for 20 psi minimum pressure.
10. Check lubricating oil level as follows:
    (a) Open Crankcase Exhauster circuit breaker located on Control Compartment Panel.
    (b) With engine Idling and locomotive on a level track, oil level should be at high mark on Bayonet Gauge.
    (c) CLOSE Crankcase Exhauster circuit breaker.

11. Make sure Crankcase Exhauster Light under Engine Start Switch is ON.
12. The Ground Relay and Traction Motor Blower Indicating Light under Engine Start Switch should be OFF and each traction motor blower running.
13. Move the Engine Control Switch to RUN.

E. STARTING ENGINE ON "B" UNIT

In order to start the Diesel engine on a "B" unit the multiple unit jumpers must be connected to an "A" unit. On the "B" unit it involves the Control Compartment Panel, the Battery Switch, and the Engine Control Switch.

The Control Compartment Panel is located in the engine room directly ahead of the main generator and faces the front end door.

The Control Compartment circuit breaker panel, Battery Switch and Engine Control Switch in the Control Compartment are all mounted in the same relative positions as on the "A" unit.

1. ON "A" UNIT
   (a) Close Battery Switch.
   (b) Place Throttle Handle in Idle, Selector and Reverse Handles in Off.
   (c) Close Control Negative and Battery circuit breakers on Control Compartment Panel.
   (d) Close Control and Fuel Pump circuit breakers and push Run button on Emergency Engine Stop switch on Engineman's Control Stand.
2. ON "B" UNIT
   (a) Close Battery Switch.
   (b) Close all circuit breakers on Control Compartment Panel.
   (c) Follow Engine starting procedure as outlined in items 5-13 STARTING ENGINE ON "A" UNIT.

F. STARTING ENGINE ON "B" UNIT FOR OPERATION BY HOSTLER'S STATION (If Used)

In starting the Diesel engine on a "B" unit equipped with a Hostler's Station, there is involved the circuit breakers on

the Control Compartment and Hostler's Station, the Battery Switch and Engine Control Switch.

The Engine Control Switch is located in the back wall of the Control Compartment to the right hand side.

The Control Compartment Panel is located on the front side of the Control Compartment.

A control panel at the Hostler's Station contains the Fuel Pump and Control Breakers.

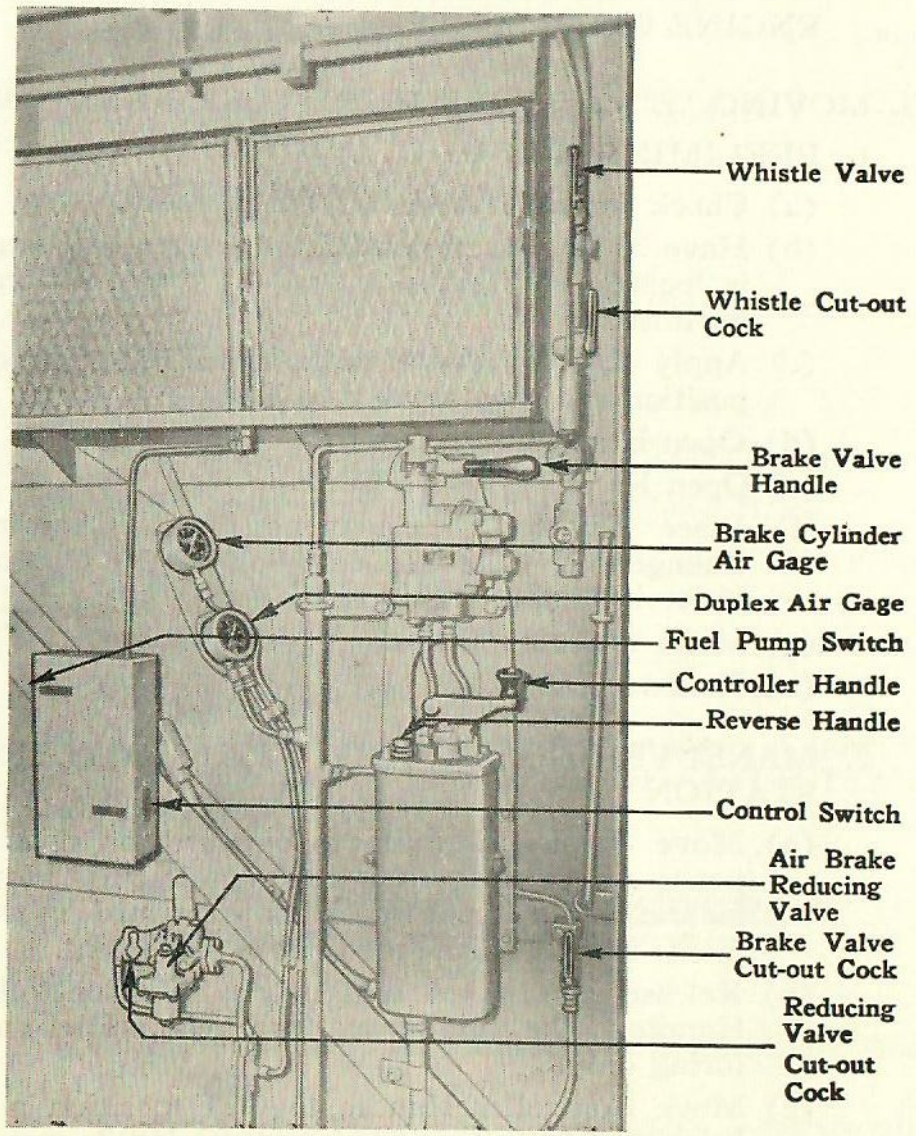

Fig. 6 — Hostler's Station

To Start Engine:

1. Place Controller Handle at Hostler's Station in OFF position.
2. Place Reverse Handle in OFF position.
3. Close Battery Switch.
4. Close all circuit breakers on the Control Compartment Panel.
5. Close the Control and Fuel Pump breakers on the Control Panel at the Hostler's Station.
6. Follow procedure outlined in items 5-13 STARTING ENGINE ON "A" UNIT.

G. MOVING "B" UNIT WITH HOSTLER'S STATION

1. PRELIMINARIES

(a) Check for main reservoir air pressure.

(b) Have 70 pounds of control air pressure. Gauge is located on right side wall at Control Compartment.

(c) Apply Brake Valve Handle in full Application position and then move it to Release position.

(d) Open Brake Valve Cutout Cock.

(e) Open Reducing Valve Cock.

(f) Place Controlled Emergency and Charging Changeover Cutout Cocks on D-24 Control Valve in "Passenger" position.

(g) Make brake application.

(h) Release Handbrake.

2. MANEUVERING "B" UNIT WITH HOSTLER'S STATION

(a) Move Reverse Handle to forward or reverse position depending upon direction desired. Move handle toward side panel for forward movement; toward engine for reverse movement.

(b) Release air brakes and notch out Controller Handle. The unit moves in series-parallel motoring only.

(c) Move Controller Handle to OFF position and bring unit to full stop before reversing its movement.

3. LEAVING "B" UNIT AFTER OPERATION FROM HOSTLER'S STATION

(a) Apply hand brake.

(b) Move brake valve handle to release position.

(c) Close brake valve cutout cock.

(d) Close reducing valve cutout cock.

(e) Move brake valve handle to full application position and remove.

(f) Turn Engine Control Switch to OFF position.

(g) Open Fuel Pump and Control breakers at Hostler's Station.

(h) Open all circuit breakers on Control Compartment Panel.

(i) Open Battery Switch.

H. BEFORE MOVING A TRAIN

1. Install Brake Valve Handles and Reverse Lever.
2. Check main reservoir air pressure.
3. Check control air pressure—normal 70 psi.
4. Place Brake Pipe Cutout Cock in OPEN position.
5. Make brake application, release Hand Brake.
6. The Dead Engine Cock located on the D-24 control valve must be in LIVE position.
7. Test sanders.
8. Make air brake test.
9. Have at least 120°F water temperature, if possible, before notching up. See ENGINE WATER TEMPERATURE GAUGE.

V OPERATING PROCEDURE

A. MOVING A TRAIN

1. Close Generator Field Breaker on Engineman's Control Stand.
2. Move Reverse Handle to FORWARD or REVERSE position, depending on direction desired.

3. Move Selector Handle to Position 1, (or to Position 4 if locomotive is equipped with automatic transition).
4. Depress Safety Control pedal.
5. Release brakes.
6. Open Throttle.

B. STOPPING A TRAIN

1. Close Throttle Handle to IDLE and apply air brakes. If leaving engineman's position move Selector and Reverse Handles to OFF.

C. REVERSING LOCOMOTIVE

1. Bring locomotive to a full stop.
2. Move Selector Handle to No. 1 position if locomotive is equipped with manual transition, not necessary if automatic transition is used.
3. Move Reverse Handle to opposite direction.
4. Depress Safety Control pedal.
5. Release brakes.
6. Open Throttle.

D. SHUTTING DOWN DIESEL ENGINE

1. "A" UNIT
   (a) Open Generator Field Breaker located at Engineman's Control Stand.
   (b) Move Engine Control Switch to OFF position.
   (c) Apply hand brake and release air brakes.
   (d) Open all other switches and circuit breakers at Engineman's Control Stand and Control Compartment Panel.
   (e) Open Battery Switch.

2. "B" UNIT
   (a) Turn Engine Control Switch on Engine Control Panel to OFF position.
   (b) Open Fuel Pump and Control Switches on the Control Panel at the Hostler's Station (If Used).
   (c) Open all circuit breakers on Control Compartment Panel.
   (d) Open Battery Switch.

F. MANUAL TRANSITION

When starting a train with a Road Freight-Passenger locomotive equipped with manual transition, move the Selector Handle to position 1. As the speed increases, the pointer on the speedmeter will move to zones 2, 3 and 4 at which time move the Selector Handle to its corresponding positions 2, 3, or 4.

As locomotive speed decreases move Selector Handle to the corresponding position as indicated on the transition scale. The Selector Handle may be moved to any motoring position as indicated with the Throttle in any position.

The speed range for each Selector Handle position and for various locomotive gearing is shown in the following table. These speed ranges are shown by the zones 1, 2, 3, and 4 on the Speedmeter or Speed Recorder, if used.

SELECTOR HANDLE POSITION	GEARING — MPH For Locomotive Maximum Speeds of (4 Motor Equipment—40 Inch Wheels)			
	65	75	80	92
1	0-17	0-19	0-21	0-24
2	17-23	19-27	21-29	24-33
3	23-49	27-55	29-60	33-68
4	49-65	55-75	60-80	68-92

G. AUTOMATIC TRANSITION (if used)

When starting a train with a Road Freight-Passenger locomotive equipped with automatic transition, move the Selector Handle to position 4. This permits automatic transition to take place at predetermined locomotive speeds during acceleration or deceleration.

The approximate speeds at which the transition relays function or at which the engineman may move the Selector Handle to enforce manual supervisory control over the automatic, are as shown in the following table.

MOVE SELECTOR HANDLE FROM		GEARING—MPH For Locomotive Maximum Speed of (4 Motor Equipment—40 Inch Wheels)			
Acceleration	Deceleration	65	75	80	92
1 to 2	2 to 1	17	19	21	24
2 to 3	3 to 2	23	27	29	33
3 to 4	4 to 3	49	55	60	68

H. THROTTLE HANDLING

An inherent feature of the 1600 HP Road Freight-Passenger locomotive provides throttle control of tractive effort. This offers two advantages. First, it affords the engineman the ability to control, by throttle notch position, the amount of tractive effort to be developed. Second, it provides a definite protection against excessive overload current on the traction motors and generator.

The proper use of this feature offers much in improved train handling as well as protection to the electrical equipment. It is important therefore that the engineman thoroughly understands its proper use, since it does require slightly different throttle handling than for other types of locomotives not so equipped.

1. How It Works

   For each throttle position a definite maximum load current and corresponding tractive effort may be developed. The increase, as the throttle is advanced from one position to the next, is made immediately but smoothly. Since, however, the total tractive effort of the locomotive is divided into eight steps available on the eight throttle notches, it is necessary to advance all the way into the 8th notch in order to develop full tractive effort. Further, since maximum current is controlled, it is perfectly safe, so far as electrical or mechanical equipment is concerned, to advance the throttle rapidly into the 8th notch: in fact this is not only desirable, but necessary under certain starting conditions.

2. How It Is Used

   It should be well understood that the worst treatment that can be given a traction motor is to allow it to stand at "stall" condition for any appreciable length of time with load current applied to it. It is therefore most important, having given due care to insure that the brakes are released and train slack is out to:

   (a) Start the locomotive to move as quickly as possible, and

   (b) Accelerate to a speed which will bring the loadmeter pointer down into the Green zone in a minimum time.

Therefore, in making a start, the throttle should be advanced promptly to a notch that will start locomotive movement. If after starting, acceleration is too fast or until it is certain that all slack is out, the throttle may be backed off as required to maintain desired locomotive speed. As soon as the slack is out, the throttle may be advanced as fast as desired to suit operating conditions. It is good practice to hesitate at each notch position to allow the engine to come up to the new notch speed which is indicated when the loadmeter pointer has come to rest at a new position.

3. Starting Passenger or Light Trains

   For normal starting of passenger and light trains, no appreciable difference in throttle handling will be noted from other types of equipment except the prompt response obtained for each throttle notch advance.

4. Normal Starting of Heavy Freight Trains

   Normally it is not necessary to "bunch" the slack. If the train is known to be stretched, as soon as the brakes are fully released, throttle should be advanced immediately to whatever notch is required to start movement. Then adjust up or down to suit desired operating conditions bearing in mind desirability of accelerating the train to where the loadmeter registers in the Green zone in minimum time. For normal level grade starting, if no movement is obtained when the throttle has reached 5th or 6th notch, shut off throttle and recheck to insure that the brakes are fully released.

5. For Starting Heavy Trains on Severe Grades

   It is occasionally necessary to take as much as the 7th or 8th notch to make a start. The engineman must, of course, use due care in handling the train slack and to time his power application to insure that brakes are released. Having assured himself of slack and brake conditions, he should have no hesitancy in advancing the throttle quickly into even the 8th notch to get the train moving. While the load current will be high, the control limits it to a value

corresponding to approximately the maximum short time rating as shown on the loadmeter. The important thing is to get the locomotive moving and thus keep to a minimum the length of time during which heavy load current is applied to the motors before they start to turn.

I. WHEEL SLIP

1. Wheel slip is indicated by a warning light and buzzer. The occasional wheel slip will be corrected by automatic power reduction and smooth reapplication.
2. Upon repeated slip indication, apply sand.
3. If this does not correct slipping, reduce throttle.
4. When a spinning slip develops it cannot be arrested by sand application. Throttle must be reduced until spinning stops, then apply sand and re-apply power.
5. The loadmeter is another means by which a wheel slip may be detected. A sudden drop of the loadmeter pointer or an abnormally low reading may be an indication of wheel slip.
6. In multiple-unit operation under adverse rail conditions, excessive wheel slip can be avoided by placing the Engine Control Switch of the lead unit in the number 6 position.
7. A continuous wheel slip warning may indicate a locked axle. Check should be made to insure free rotation of all wheels.

J. OPERATING WITHOUT LOADMETER

If the loadmeter becomes inoperative the following table gives the approximate minimum speeds at which the locomotive may be operated continuously in the 8th notch.

APPROXIMATE MINIMUM CONTINUOUS SPEEDS

8th Notch Operation—40-Inch Wheels

MAX. SPEED—MPH	GEAR RATIO	MIN. SPEED—MPH
65	74/18	8.5
75	65/18	10.0
80	64/19	10.5
92	62/21	12.0

K. COUPLING LOCOMOTIVE UNITS

When making up a locomotive using "A" and "B" units it is necessary that the various controls be properly positioned.

1. All switches, circuit breakers and cutout cocks in the leading "A" unit should be in the same position as when operating a single "A" unit.
2. Place the Rotair Valve on the leading "A" unit in Freight position if the train is 50 to 75 cars or more and Passenger position if the train is to be 50 to 75 cars or less.
3. On the trailing "A" unit, all switches and circuit breakers must be ON as in the leading "A" unit, with the exception of the Control, Generator Field and Fuel Pump breakers on the Engineman's Control Stand. These must be in the OFF position. The Throttle must be in IDLE, Selector Handle in OFF and the Reverse Handle placed in OFF position and removed. The Rotair Valve handle must be in Passenger Lap if the train is 50 to 75 cars or less and must be in Freight Lap if the train is 50 to 75 cars or more. Place Automatic Brake Valve handle in Running position and Independent Brake Valve Handle in Release position and remove both handles.
4. On trailing "B" units with Hostler Stations, all switches and circuit breakers should be in the same position as when moving a single "B" unit with the exception of the Fuel Pump and Control breakers at the Hostler's Station, both of which must remain in OFF position. The Brake Valve Cutout Cock and the Reducing Valve Cutout Cock at the Hostler's Station should be closed. The Brake Valve Handle and Reverse Handle should be removed.
5. On the D-24 Control Valve set the Charging Change-over Cock in the same position on all units as the Rotair Valve on the leading "A" unit.
6. On the D-24 Control Valve on "B" units, set the Controlled Emergency Cutout Cock in the same position as the Charging Change-over Cock — "F" for freight and "P" for passenger.

7. See that air hoses and multiple-unit jumpers are properly connected and the air line cutout cocks are open.

L. SEPARATING UNITS

1. Before separating or closing cocks between units, make a full service automatic application from the lead unit.
2. Set the reducing valve at or near the brake pipe pressure carried on the leading "A" unit.
3. Close all end cocks on both ends of unit, remove multiple unit jumpers and disconnect steam line (if used).

VI AIR EQUIPMENT

A. 24-RL AIR BRAKE EQUIPMENT

The 24-RL brake equipment is used on road freight-passenger locomotives. Details of this equipment vary on different railroads to meet specific operating requirements.

The equipment consists primarily of the automatic brake valve, independent brake valve, brake pipe cutout cock, feed valve and D-24 control valve.

1. Automatic Brake Valve Handle has six positions, namely: "release", "running", "first service", "lap", "service" and "emergency".
   (a) In Release Position (extreme left position of brake valve handle) controlled full release is obtained in which the large capacity feed valve provides a high rate of air flow to the brake pipe at feed valve pressure without the liability of overcharge.
   (b) In Running Position the air flow to the brake pipe is the same as older feed valve capacities. This position is used to release the brakes when the brakes are charged and ready for use and when the brakes are not being operated.
   (c) First Service Position provides for an initial normal service rate of brake pipe reduction to initiate quick service on the train brakes, after which a slower rate is imposed, allowing the brake pipe pressure to readjust itself throughout the train thus avoiding a heavy reduction at the front end.
   (d) Lap Position is used while holding the brakes applied after a service application until it is desired either to make a further brake pipe reduction or to release the brakes.
   (e) Service Position causes the locomotive brakes and train brakes to apply uniformly on both a time and pressure basis by delaying the beginning of effective brake cylinder pressure development on the locomotive to coincide with that on the train.
   (f) Emergency Position applications are adjustable to provide slack control according to the services (Rotair Valve Position). This feature provides a rapid development of locomotive brake cylinder pressure for passenger and short freight trains: or a controlled build-up for long freight trains.
2. First Service Cock on the back side of the automatic brake valve is used for cutting-in or out the first service operation of the brake valve. When the handle is towards the engineman, it is cut-in.
3. Selector Cock on the rotary valve seat portion has two positions; "MR" main reservoir (handle away from engineman) and "FV" feed valve (handle towards engineman). With the handle on "MR" and the automatic brake valve handle in release position, main reservoir air flows to the brake pipe unaffected by the regulating portion of the feed valve and overcharging is possible. When the handle is moved to "FV" position and the automatic brake valve in release or running position, the brake pipe is connected to the control pipe and feed valve pressure will be maintained in the brake pipe.
4. Brake Pipe Cut-Out Cock on the lower portion of the automatic brake valve is used for cutting the brake valve in or out. When the handle is pointing away from the engineman, the brake valve is cut in and in the vertical position it is cut out.

5. Safety Control Cut-Out Cock on the service application portion is used to cut in or out all safety devices (deadman control, locomotive overspeed and train control if used). With the handle down, all safety devices are cut in.

6. Rotair Valve located below the engineman's instrument panel is a manually operated selector valve having four positions; freight, freight lap, passenger and passenger lap. The handle should be placed in "FRGT" position on trains of 50-75 cars or more where controlled emergency (delayed emergency action of the locomotive brakes) is desired and "FRGT LAP" on trailing "A" units. In lap position, the independent brake valve is cut out.

   The handle should be placed in "PASS" position on trains of 50-75 cars or less where the controlled emergency feature is inoperative and "PASS LAP" on trailing "A" units.

7. Control Valve located in the nose of "A" units and in the rear of "B" units when actuated by the brake valve, operates to charge, apply and release the brakes. The control valve in "B" units includes the

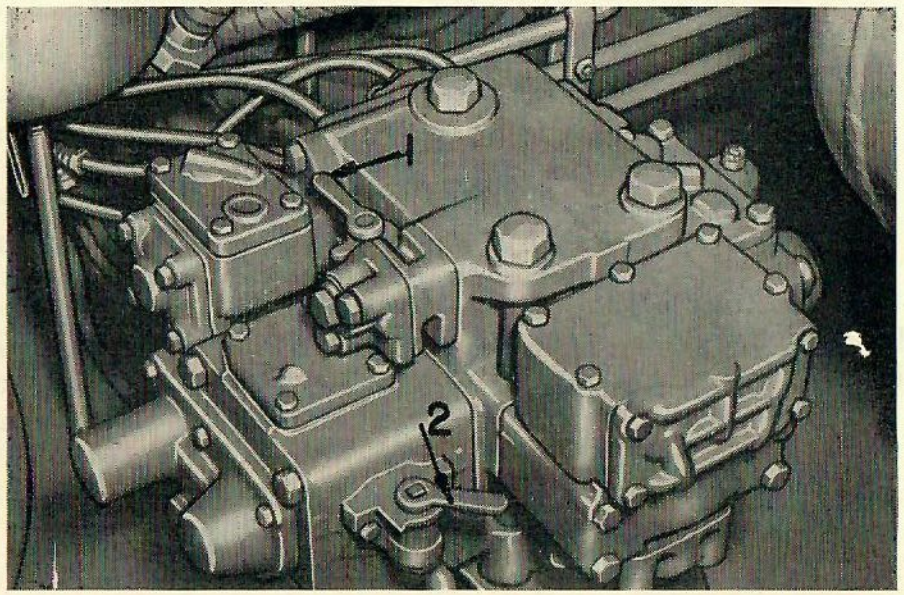

Fig. 7 — D-24 Control Valve "A" Unit

1. Dead Engine Cutout Cock
2. Charging Change-over Cock

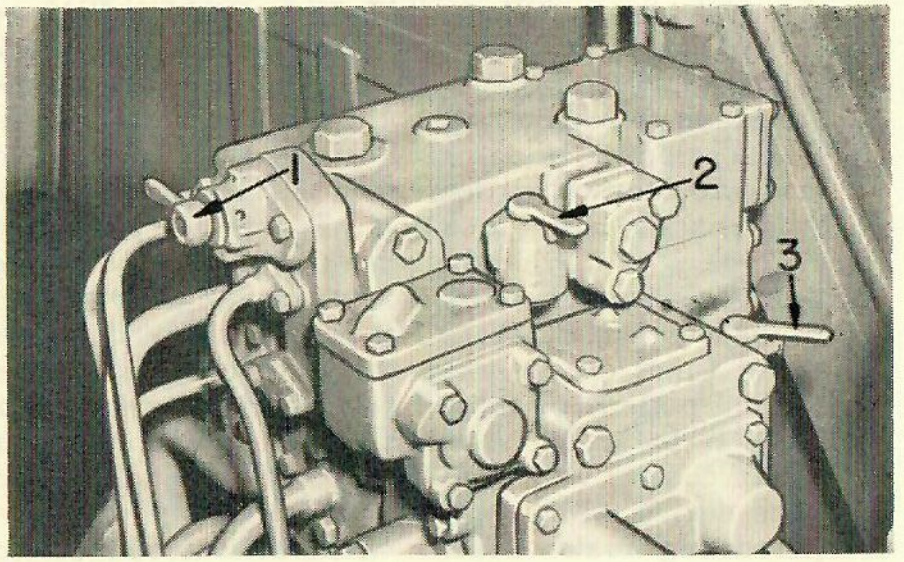

Fig. 8 — D-24 Control Valve "B" Unit

1. Controlled Emergency Cut-out Cock
2. Dead Engine Cutout Cock
3. Charging Change-over Cock

controlled emergency cock which should be positioned at "F" or "P" to correspond with the position of the the rotair valve in the leading "A" unit. Common to the control valve in both "A" and "B" units are the charging change-over cock, dead engine cock and graduated release cap. Charging Change-over Cock should be postioned at "F" or "P" to correspond with the position of the rotair valve in the leading "A" unit. When in "F", charging of the auxiliary reservoir is at a slow rate while in "P", the rate is much faster. Dead Engine Cock should be in "Live" position for normal operation and "Dead" when the locomotive is hauled dead in a train. Graduated Release Cap has two positions, graduated "Gra" and direct "Dir". This applies to automatic release of the locomotive brakes which will usually be graduated in passenger and light freight service and direct in heavy freight.

8. Independent Brake Valve Handle has two positions, release and application zone. The brake valve is of the self lapping type. Leakage is automatically controlled which insures that the brake will not release

due to leakage. When the brake valve handle is set in any position of the application zone, the valve will automatically lap when the applied pressure reaches the value corresponding to the position of the handle. The locomotive brakes may be released after an automatic application by depressing the independent brake valve handle in any position. Brakes will reapply to the setting of the handle when the handle is released.

9. Safety Control Pedal is located on the floor in front of the engineman's seat. The pedal must be depressed at all times except when the locomotive is stopped and 30 pounds or more brake cylinder pressure exists. If the pedal is released during operation, the safety control whistle will sound for two to four seconds during which time the pedal can be depressed preventing brake action. Otherwise a full service application of brakes will be made.
10. Dynamic Brake Interlock is furnished with dynamic brake equipment and is used to release or prevent an automatic brake application on the locomotive if the dynamic brake is on. Independent application and release of the locomotive brake is available at all times irrespective of dynamic brake operation.

    If the automatic brake valve is placed in the emergency position, or for any penalty application, the dynamic brake is nullified allowing the automatic to operate.
11. Pneumatic Control Switch is an air operated electric switch located in the right side of the nose compartment of the locomotive. Any penalty application of air brakes such as emergency application of brakes, safety control application of brakes, train control application (if used) and locomotive overspeed (if used) will trip this switch returning the Diesel engine to idle. The switch is reset automatically when the throttle is returned to idle and the brake recovered.

B. RECOVERY OF BRAKE AFTER PENALTY APPLICATION

1. Place brake valve in Lap, Service or Emergency.
2. Close throttle to IDLE.
3. Depress safety control pedal.
4. Allow application pipe to build up to main reservoir pressure.
5. Release brakes.

C. AUXILIARY AIR EQUIPMENT

1. Locomotive Bell Valve
   (a) The Control Valve is mounted on the brake valve pedestal between the automatic and independent brake valves.

   (b) The shutoff valve is built in the needle valve adjustment of the bell which is located under the right front corner of the locomotive frame.
2. Horn Valve
   (a) Valves in the cab ceiling control the main reservoir air pressure to the horns and are operated by rope extensions to the Engineman's Control Stand.
   (b) The horn shutoff cock is located in the nose compartment just to the right of the door.
3. Sander Valve
   (a) Located to the right of the brake valve pedestal.
   (b) The valve has two operating positions, Forward and Neutral.
   (c) "A" units having a four trap system, sand in forward movement only.
   (d) "A" units having an eight trap system, sand in direction of locomotive movement as this is electrically controlled through the reverser.
   (e) All "B" units are equipped with eight sand traps automatically controlled from "A" unit.
   (f) In many installations sanding is automatic for train line emergency applications or when the automatic brake valve handle is moved to emergency.
   (g) A sander cutout cock for each truck is located under the chassis on the right side of the locomotive near the sander automatic valve.
4. Windshield Wiper Valves
   (a) Valves located at the Engineman's and Fireman's position provide independent control of speed.
   (b) The shutoff globe valve for air supply to wipers is located in the nose compartment just to the right of the door and behind the Horn cutout cock.

VII MISCELLANEOUS OPERATING INSTRUCTIONS

A. CHANGING OPERATING ENDS

1. On Unit Being Cut Out
   (a) Make a 20 pound brake pipe reduction with the automatic brake valve, after which move the brake valve handle to Lap position.
   (b) Move the independent brake valve handle to Release position and observe that the brakes are still applied.
   (c) Close the brake pipe cutout cock (vertical position).
   (d) Place the rotair valve in either **FRGT LAP** for a train of 50-75 cars or more or **PASS LAP** for a train of 50-75 cars or less.
   (e) Move the automatic brake valve handle to Running position and remove both handles.
   (f) Place reverse handle in **OFF** position and remove. To do this it is necessary that the selector handle be in **OFF** position and the throttle in IDLE.
   (g) On the Engineman's Control Stand open control and generator field breakers; leave fuel pump switch closed.
2. On Unit Being Cut In:
   (a) Put reverse handle in place and leave in **OFF** position.
   (b) Insert automatic and independent brake valve handles.
   (c) Place rotair valve in **PASS** for a train of 50-75 cars or less and **FRGT** for a train of 50-75 cars or more.
   (d) Move independent brake valve handle to Application position.
   (e) Open brake pipe cutout cock.
   (f) Move automatic brake valve handle to Emergency position, then back to Lap.

   (g) When changing feed valve pressures, depress the independent brake valve handle in full Application position for about 8 seconds to avoid possibility of an overcharge.
   (h) Move automatic brake valve handle to Running or Release position.
   (i) Close control and fuel pump breakers on the Engineman's Control Stand.
   (j) **OPEN** fuel pump switch On End Being Cut Out.
   (k) Close generator field breaker on Engineman's Control Stand.
   (l) Place foot on safety control pedal and release independent brake.

B. DYNAMIC BRAKING OPERATION (if used)

1. When operating in Dynamic Braking the engineman controls the amount of braking effort with the selector handle. The Dynamic Brake may be applied with the locomotive operating in either forward or reverse motion. The position of the pointer on the Braking Scale of the loadmeter indicates the amount of braking effort being developed. Continuous braking may be maintained at any value within the Green zone of the Braking scale, except as described under "Dynamic Braking Limits". No operation is permitted in the Red zone of the Braking scale. If the pointer goes into the Red zone the Brake Warning Light will come on and the alarm will sound. Braking **MUST** be reduced to keep the pointer in the Green zone and the alarm off.

   The operation and effect of the dynamic brake on the train is similar to that of the locomotive independent air brake; braking effort is applied to the locomotive only. The same precautions for bunching the slack and preventing slack "run out" are required.

2. Dynamic Braking Limits

   Any amount of braking may be employed for unlimited time so long as the Loadmeter pointer stays within the Green zone and the Brake Warning Light and Alarm do not operate. No operation is permitted

in the Red zone of the braking scale or with the Brake Warning Alarm on. At speeds above 55 MPH, on 65 MPH geared locomotives, maximum braking should be reduced from the Red band to the Yellow marker on the braking scale of the Loadmeter. See the following table for corresponding speeds for other gearing.

DYNAMIC BRAKING LIMIT

Top Speed Gearing	Restrict to Small Marker Above
65 MPH	55 MPH
75 MPH	64 MPH
80 MPH	68 MPH
92 MPH	78 MPH

3. To Apply Dynamic Braking:

(a) Move Throttle to Idle.

(b) Have Reverse Handle Forward or Reverse depending on direction of motion.

(c) Move Selector Handle to Off and then to big "B" in the Braking range. Loadmeter Pointer will show slight movement.

(d) Bunch train slack by advancing Selector Handle cautiously into the Braking range. Do not allow Loadmeter Pointer to exceed the first White mark on the Motoring Scale until all slack is bunched.

(e) After slack is bunched advance Selector Handle into Braking range until the desired braking effort is obtained. Make handle movements slowly. Do not permit Loadmeter Pointer to enter Red band on the braking scale. If the Brake Warning Alarm comes on, reduce braking until alarm stops.

(f) The amount of braking effort obtainable varies with the train speed. To obtain maximum braking performance, the Selector Handle must be moved to maintain the Loadmeter Pointer near the top of the Green Band.

With the Loadmeter Pointer held constant, the braking effort will increase as speed decreases until it reaches maximum value at approximately 19 MPH for 65 MPH gearing. Below this speed, braking effort will gradually fall off to reach 0 at 0 MPH.

The speed at which the maximum braking effort is reached for other gearings is as follows: 22 MPH for 75 MPH gearing, 23 MPH for 80 MPH gearing and 27 MPH for 92 MPH gearing.

(g) It is permissible to start from a standstill on a downgrade with dynamic brake applied.

(h) When braking a heavy train on a severe grade, the maximum dynamic braking may not be sufficient to hold the desired train speed. An application of the Automatic air brake may be used in addition to the dynamic to maintain desired train speed. The Dynamic Braking Interlock will hold the locomotive brakes released for any position of the automatic brake valve other than emergency. (See DYNAMIC BRAKE INTERLOCK and PNEUMATIC CONTROL SWITCH).

4. Release of Dynamic Brake

(a) Reduce braking slowly; pause when the Loadmeter pointer indicates at the first White mark on the Motoring scale to prevent slack run out.

(b) Handle can now be moved to Off or into Motoring.

(c) A light application of the Independent Air Brake will aid in preventing slack run out.

5. Cutout of Dynamic Brakes

(a) If the Engine Control Switch is turned to Idle, dynamic braking on that unit will be inoperative.

(b) Cut out dynamic brake only when Selector Handle is "Off"; this avoids surges on the equipment or on the train. For the same reason, dynamic brake must not be cut in, except with Selector Handle in "Off".

6. Dynamic Braking With Lead Unit Idling or Shut Down.

The loadmeter will not operate, therefore the alarm light and buzzer will indicate when maximum braking has been reached. Reduce braking to stop the alarm.

Whenever lead unit is cut out, keep engine idling if conditions permit. This maintains battery charging, air pressure, engine temperature, etc.

(a) Conditions in Leading Unit
   (1) Place Engine Control Switch in Idle or Off.
   (2) Fuel pump breaker on Engineman's Control Stand should be closed.
   (3) Main Control Negative and MG breakers on Control Compartment Panel should be closed.
   (4) When engine must be shut down completely, open fuel pump and crankcase exhauster breakers on Control Compartment Panel.

(b) Conditions on Trailing Units
   (1) Same as for normal operation.

C. BRAKING WITH POWER

1. Gradually apply automatic brake for a light brake pipe reduction.
2. Release locomotive brakes by depressing independent valve handle in the Running position.
3. Reduce throttle to maintain Loadmeter pointer in Green band of Motoring scale as train speed decreases. Move throttle to Idle before train comes to a dead stop.
4. On locomotives equipped with manual transition move the Selector Handle into the position indicated by the speedmeter.

D. FASTER AIR PUMPING

1. Generator Field breaker located on Engineman's Control Stand must be Off.
2. Reverse Handle must be in OFF position.
3. Selector Handle must be in Position 1.
4. Open throttle as desired up to Notch 5.

E. EMERGENCY ENGINE SHUT DOWN

A Stop-Run Switch is located on the Engineman's Control Stand. When the Red "Stop" Button is pushed it will shut down the engine of the unit and simultaneously all other engines of a multiple unit locomotive. It is provided for "emergency" use only. Normal shut downs should be made with the Engine Control Switch.

To restart engines of a single or multiple unit locomotive after shut down by Emergency Stop-Run Switch:

1. Locomotives made up entirely of new units; i.e., units having Engine Control Switch on Control Compartment.
   (a) Reset switch by pushing in Black "Run" Button.
   (b) Start engine on any unit in the normal manner after first turning the Engine Control Switch to the OFF position.
2. Locomotives made up of new units in combination with old; i.e., old units have the Engine Control Switch mounted on the panel across the aisle from the engine governor.
   (a) Push in the RUN button on units having the Stop-Run Switch.
   (b) Turn Engine Control Switch on ALL units to OFF position before starting any unit.
   (c) Start engines in the normal manner.

Note: On the older units an electrical interlocking circuit prevents operation of the engine starting contactors on any unit until the Engine Control Switches on ALL units are turned to OFF position.

F. OPERATING THROUGH WATER

Do not exceed 2 or 3 MPH if there is water above the railhead. Do not pass through water over 4 inches above railhead.

G. PASSING OVER RAILROAD CROSSINGS

The severe mechanical shocks received by traction motors when passing over railroad crossings at high speed may cause the brushes to bounce and flash-over the traction motors. At high speeds, reduce throttle to

5th notch or below while all units pass over the crossing. This is not necessary at very low speeds.

It is also desirable to reduce dynamic braking at high speeds over crossings for the same reason.

H. TAKING DIESEL ENGINE "OFF THE LINE" IN M-U OPERATION

Turn the Engine Control Switch to IDLE position. If it becomes necessary to stop the engine, turn Engine Control Switch to OFF position and open the fuel pump and exhauster breakers on the Control Compartment Panel.

I. PUTTING DIESEL ENGINE "ON THE LINE" IN M-U OPERATION

If Engine has been shut down:

1. Close fuel pump and exhauster breaker on Control Compartment Panel.
2. Start Engine in usual manner.

If lead unit throttle is in Idle, turn Engine Control Switch directly to Run.

If lead unit throttle is in a Running Notch, turn Engine Control Switch slowly to Run pausing 3 seconds at intermediate positions 2, 4, and 6 to gradually bring engine up to speed and load.

J. PARTIAL LOAD OPERATION

The Diesel engine may be operated at partial load by moving the Engine Control Switch to position 2, 4, or 6 regardless of throttle position.

Position 2, 4, or 6 corresponds to throttle notch 2, 4, or 6. After setting the Engine Control Switch at any of these intermediate points, the Diesel engine speed will increase only up to that point although the throttle may be in a higher notch. The positioning of the Engine Control Switch thereby limits the output of the Diesel engine.

In M-U operation this feature provides for:

1. Reduced power on the lead unit to overcome excessive wheel slip under adverse rail conditions.

2. Reduced power operation of any unit to accommodate power plant difficulties which may make full power operation undesirable.
3. Reduced power break-in of an overhauled engine.

K. TOWING DEAD LOCOMOTIVE (Brake Pipe Hose Only Connected)

In freezing weather, drain engine and steam generator (if used) water systems. Brake equipment on one or more "dead" units which are in multiple with a "live" leading unit should be set up the same as "live" trailing units. It is recommended that brake equipment on each unit of a "dead" multiple unit locomotive which is not in multiple with a "live" unit should be set up as a single "dead" unit as follows:

"A" UNIT

1. Close the brake pipe cutout cock and remove automatic brake valve handle in Running position.
2. Place dead engine cock in Dead position on D-24 control valve.
3. Place charging changeover cock in Passenger position on D-24 control valve.
4. Remove or keep independent brake valve handle in Release position.
5. Place rotair valve handle in Passenger position.

"B" UNIT

1. Place dead engine cock in Dead position on D-24 control valve.
2. Open brake valve cutout cock (hostler's station).
3. Remove brake valve handle in Full Application position, then move brake valve stem to Release position, using reverse side of brake valve handle.
4. Place charging changeover and control emergency cocks in Passenger position.
5. Close reducing valve cutout cock (hostler's station).
6. Open end cocks on actuating and application release pipes on one end of unit.

L. OPERATING WITH STEAM LOCOMOTIVE HELPER

Before using a steam locomotive as a helper, it should first be determined that the steam locomotive can pull its share of the tonnage at or above the rated speed of the Diesel-electric locomotive. The tonnage rating of steam locomotives used in helper service is sometimes based on speeds below the continuous rated speed of the Diesel-electric locomotive.

It therefore follows that if the helper locomotive can not pull its share of the tonnage which is in excess of the continuous tonnage rating of the Diesel-electric locomotive, the Diesel-electric locomotive will endeavor to pull more than its share which may result in eventual damage to the equipment.

When operating with a helper watch the loadmeter; overloading of the Diesel-electric locomotive will be indicated by the loadmeter pointer moving into the Yellow zone. Reduce the Diesel-electric locomotive throttle and allow the train speed to drop until the helper locomotive assumes its share of the tonnage; then set the Diesel-electric locomotive throttle in the position that allows the loadmeter pointer to remain in the upper part of the Green zone.

M. DOUBLE HEADING BEHIND STEAM LOCOMOTIVE

When preparing for double heading a Diesel-electric locomotive behind a steam locomotive, make a full service application and close the brake pipe cutout cock. Brakes are then controlled from the steam locomotive but the engineman on the Diesel-electric locomotive can make an emergency application by moving the automatic brake valve handle to emergency position. He can release the brakes by depressing the independent brake valve handle.

N. OPERATING WITH LEAD UNIT DOWN

1. Turn Engine Control Switch on lead unit to Off.
2. Close battery switch on lead unit.

3. Close main Control Negative Breaker on the lead unit Control Compartment Panel—and Lighting Breakers only as required.
4. Close Battery Breaker on lead unit Control Compartment Panel.
5. Open all other circuit breakers on lead unit Control Compartment Panel.
6. Close Control, Fuel Pump and Generator Field Breakers on the lead unit Engineman's Control Stand.
7. Dynamic braking will be inoperative on lead unit. (See Dynamic Braking with Lead Unit Down.)

Note: With engine dead, battery charging generator ceases to function. The battery voltage will weaken enough in a few hours to prevent further locomotive operation.

O. OPERATING WITH DEAD BATTERY ON LEAD UNIT (Without Headlight)

1. Turn Engine Control Switch on lead unit to Off.
2. Open battery switch on lead unit.
3. Open all circuit breakers on Control Compartment Panel and Electric Cab Heater Circuit Breaker (if used).
4. Open Fuel Pump and Control Breakers and close Generator Field Breaker on Engineman's Control Stand in lead unit.
5. On Trailing "A" Unit or "B" Unit with Hostler's stand, close Fuel Pump and Control Breakers on Engineman's or Hostler's Control Stand.
6. Dynamic Brake can not be used.

P. OPERATING WITH DEAD BATTERY ON LEAD UNIT (With Headlight).

On Lead Unit:

1. Turn Engine Control Switch to Off.
2. Open battery switch.
3. Open Electric Cab Heater Circuit Breaker (if used.)

4. Open all circuit breakers on Control Compartment Panel except Headlight, Cab Light and Engine Room Light Breakers.
5. Open Fuel Pump and close Generator Field and Control Breakers on Engineman's Control Stand.

On Trailing "A" Unit or "B" Unit with Hostler's Stand

1. Close Fuel Pump and Control Breakers on Engineman's or Hostler's Control Stand.
2. Make sure all circuit breakers on Control Compartment are closed.

Caution: Reverse Handle on trailing unit must be in OFF and removed.

Q. ENGINE WATER TEMPERATURE CONTROL

The engine water temperature is controlled by a single radiator fan and a pair of radiator shutters located on the right and left sides of the locomotive.

The speed of the fan and the positioning of the shutters are automatically controlled by the temperature of the water entering the Diesel engine. If in the event of high water temperature or by inspection, it is found that either the fan or shutters or both are not functioning, the equipment can be operated manually.

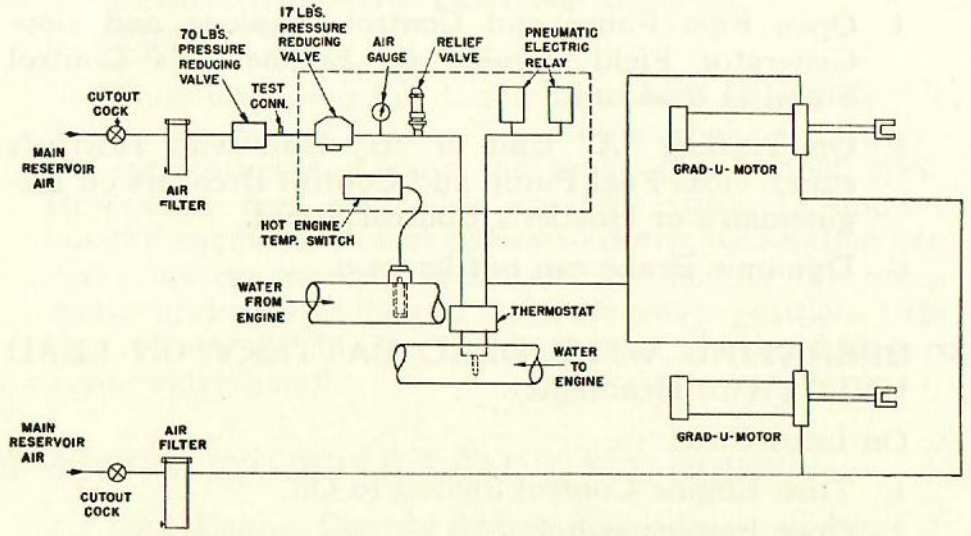

Fig. 9 — SHUTTER MOTOR LINKAGE

For automatic operation, the radiator fan control switch should be in "automatic" position on the control panel mounted under the radiator compartment and just forward of the fan drive shaft. Both shutter motor drive rod yokes should be connected to the shutter operating links with link locking pins removed and placed in receptacle below shutter operating mechanism. Both cut-out cocks should be open and the air pressure gauge should show 15 to 17 psi with the shutters closed and the fan not operating.

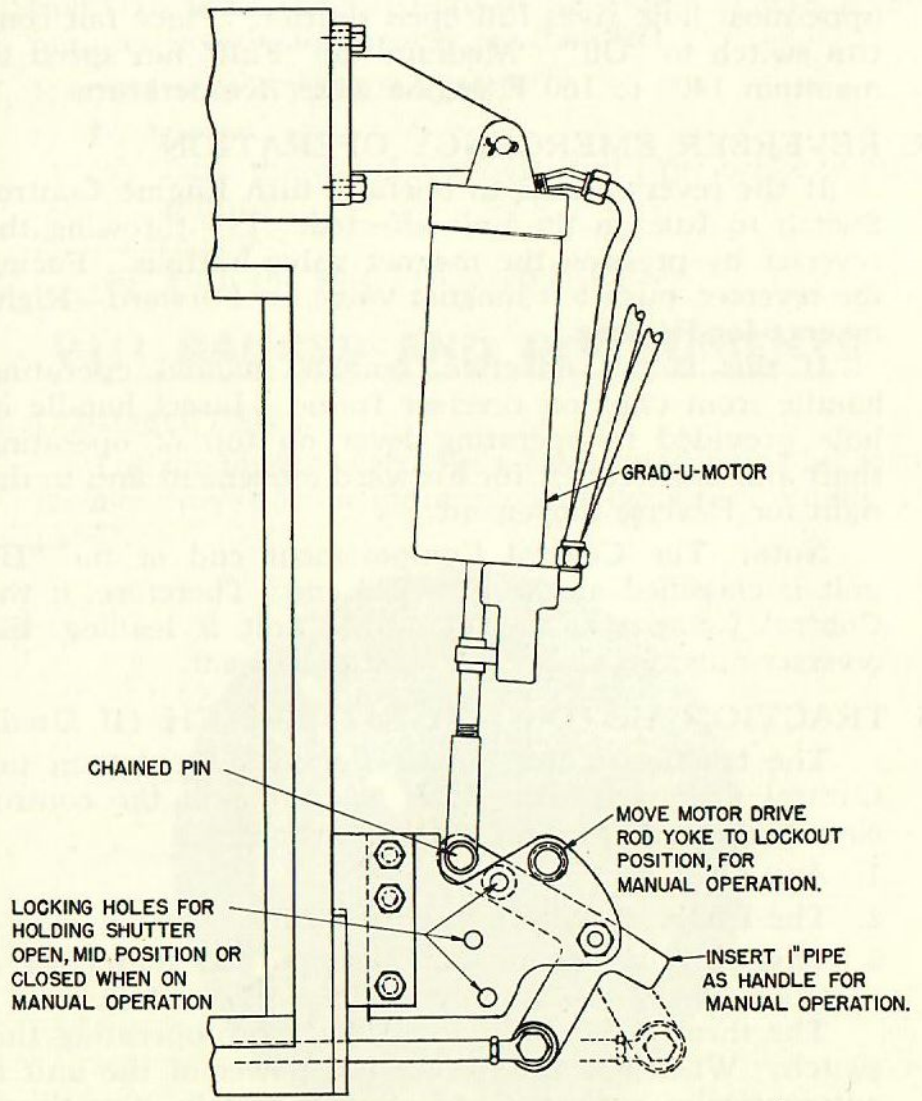
GRAD-U-MOTOR
CHAINED PIN
MOVE MOTOR DRIVE ROD YOKE TO LOCKOUT POSITION, FOR MANUAL OPERATION.
LOCKING HOLES FOR HOLDING SHUTTER OPEN, MID POSITION OR CLOSED WHEN ON MANUAL OPERATION
INSERT 1" PIPE AS HANDLE FOR MANUAL OPERATION.

Fig. 10 — SCHEMATIC ARRANGEMENT ENGINE TEMPERATURE CONTROL

In an emergency, the equipment can be operated manually by first closing the cutout cocks to both air filters and then bleeding the system by opening the drain valve in the base of each filter. Remove one inch pipe from receptacle below shutter operating mechanism and apply to shutter bell-crank arm. Pull down on pipe and remove chained pin from shutter motor yoke. Place yoke in lockout position and reapply chained pin. Position shutter operating link with locking pin in one of the three holes provided for a full open, mid-position or full closed shutter. The operating link positioned at the uppermost hole gives full open shutter. Place fan control switch to "Off", "Medium" or "Full" fan speed to maintain 140° to 160°F engine water temperature.

R. REVERSER EMERGENCY OPERATION

If the reverser fails to operate, turn Engine Control Switch to Idle on the unit affected. Try throwing the reverser by pressing the magnet valve buttons. Facing the reverser, push left magnet valve for Forward—Right magnet for Reverse.

If this is not effective, remove manual operating handle from clips on reverser frame. Insert handle in hole provided in operating lever on top of operating shaft and move to left for Forward movement and to the right for Reverse movement.

Note: The Control Compartment end of the "B" unit is classified as the Forward end. Therefore, if the Control Compartment end of the unit is leading, the reverser must be set for Forward movement.

S. TRACTION MOTOR CUTOUT SWITCH (If Used)

The traction motor cutout switch is located in the Control Compartment. It is connected in the control circuits and provides for cutting out:

1. Any ONE motor.
2. The PAIR of motors in either truck.
3. This permits cutting out a single bad motor, or a truck-pair of motors in event of a blower failure.

The throttle MUST be in Idle before operating this switch. When motors are cut out power of the unit is automaticaly restricted to approximately two-thirds horsepower.

In event the ground relay trips, the motor cutout switch may be used to isolate motors 2 or 3 to determine location of trouble.

T. CIRCUIT BREAKERS

Circiut breakers are used in all control circuits which will trip and open whenever an overload occurs. Breakers, suitably identified, are located at the engineman's position and on the Control Compartment Panel.

If a circuit breaker should trip, the handle will be approximately midway between ON and OFF. To reset, move handle to OFF position and then to ON position. In some cases it may be necessary to wait a few minutes before the breaker can be reset.

U. HANDBRAKE OPERATION

1. To Apply:
   (a) Turn the wheel clockwise until the brake is fully applied.
2. To Release:
   (a) Turn the wheel counterclockwise.

VIII GAUGES AND INSTRUMENTS

A. LOADMETER

The loadmeter is strictly a color band guide for locomotive operation in motoring and dynamic braking (if used).

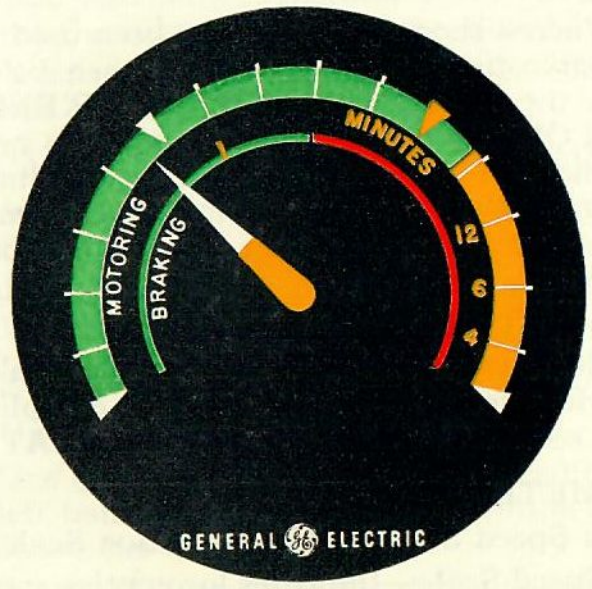

Fig. 11 — LOADMETER

1. Motoring

The pointer position on the Motoring scale indicates the amount of tractive effort being developed or the load on the traction motors when pulling a train.

The Green zone represents normal operation; in this zone operating time is unrestricted. The Yellow zone indicates short time load capacity of the traction motors; operation in this zone is principally for acceleration. The point on this scale where the color band changes from Green to Yellow indicates the Maximum load at which Continuous operation may be maintained.

2. Short Time Load Operation

For operating guidance, on short heavy grades or in emergency, short time load limits are shown by the Yellow figures which appear beneath the Yellow band on the Motoring scale. These figures indicate the Maximum Time in minutes that operation may be maintained when the loadmeter pointer registers at their respective load values. These overload times shall not be used accumulatively and the operator must use his best judgment as to when he has used up the full allowed time, if for instance the pointer may register part time at say the twelve minute load and part time at some value above or below this point.

When a short time load has been used for the full allowable time, the load MUST then be reduced to where the pointer will register AT OR BELOW THE YELLOW TRIANGLE which appears near the upper end of the Green band. The load must be held below the Yellow triangle for at least twenty minutes before another overload in the Yellow zone may be repeated.

3. Dynamic Braking (If Used).

The Braking scale is the engineman's guide in applying the dynamic brake. For complete instructions see DYNAMIC BRAKE OPERATION.

B. SPEEDMETER

1. Has a Speed Scale and a Transition Scale.
   (a) Speed Scale—Indicates locomotive speed in miles per hour.

   (b) Transition Scale—The outer scale is divided into four zones which correspond to the four Selector Handle positions. The Yellow Marks separating these zones indicate the speeds at which manual transition is performed. See TRANSITION.

C. BATTERY VOLTMETER

1. Has a voltage and color scale.
   (a) Voltage Scale—Indicates voltage of battery circuit.
   (b) Color Scale—Indicates battery circuit condition:
   Red (first zone)—Faulty or discharged battery.
   Silver—Battery at low charge or being discharged (normal open circuit voltage is 64 volts). Pointer stays in this band for a short time after starting the engine.
   Green—Battery receiving normal charge.
   Red—Battery being overcharged.

D. AUXILIARY GENERATOR AMMETER

Indicates auxiliary generator ampere output. It should show a reading whenever the Diesel engine is running; however, the reading will vary widely depending on the auxiliaries being operated.

If meter shows no reading, check to insure that both Battery and Auxiliary Generator Field circuit breakers on Control Compartment Panel are closed.

If still no reading is shown, minimize auxiliary load to conserve battery.

E. LUBRICATING OIL PRESSURE GAUGE

1. Located on gauge panel on wall to right of Engine Control Switch.
2. Should indicate 20-30 psi at idling speed and 45-55 psi at top engine speed.

F. ENGINE WATER TEMPERATURE GAUGE

1. "A" Unit.
   (a) One gauge is located on a pipe leading from the left bank water header to the cab heaters and is above the main generator.
   (b) A second gauge is on the right bank water header at the radiator compartment.

2. "B" Unit
   (a) There is one gauge located in the end of the left bank water header.
   (b) A second gauge is on the right bank water header at the radiator compartment.
3. Normal operating temperature is 140°F to 160°F.

G. BOOSTER AIR PRESSURE GAUGE

1. Located on gauge panel on wall to right of Engine Control Switch.
2. Indicates turbosupercharger air pressure to Diesel engine.
3. Should indicate 15-18 psi with throttle in eighth notch with engine fully loaded and lower pressures in lower throttle notches.

H. FUEL OIL PRESSURE GAUGE

1. Located on Gauge Panel on wall to right of Engine Control Switch.
2. Should indicate 35-45 psi at all engine speeds.

I. AIR GAUGES

1. "A" Unit
   (a) Two gauges are located in the cab at the engineman's position. One gauge indicates brake pipe and brake cylinder pressure. The other gauge indicates main reservoir and equalizing reservoir air pressure.
   (b) A third gauge is located on a column to the rear of the air compressor and indicates main reservoir air pressure.
2. "B" Unit
   (a) There is one gauge located on a column to the rear of the air compressor and indicates main reservoir air pressure.

J. CONTROL AIR PRESSURE GAUGE

1. "A" Unit
   (a) Mounted in nose compartment to left of door.
   (b) Control air cut-out cock located in line below and in front of gauge.
2. "B" Unit
   (a) Mounted on right wall next to Control Compartment.

   (b) Control air cut-out cock located in line below gauge.
3. Should indicate 70 psi.
4. Loss of control air pressure prevents operation of the electro-pneumatic contactors and further locomotive movement.

K. RADIATOR FAN CONTROL AIR PRESSURE GAUGE

1. Mounted within the fan control panel on column under radiator compartment and forward of radiator fan drive shaft.
2. It should indicate 15 to 17 psi for operation of the electro-pneumatic fan control switches.

IX AUTOMATIC ALARMS & SAFEGUARDS

In multiple unit operation the alarm system provides both bell and indicating light warning for the following:

(a) Low Lubricating oil pressure.
(b) Hot Engine.
(c) Steam Generator — Flame Out (If Used).
(d) Ground Relay Trip or Traction Motor Blowers Stopped.

Warning lights are provided in the operating cab for items (a), (b) and (c) and indicate for any unit.

Warning lights for (a), (b), (c) and (d) at the Engine Control Switch will indicate for that unit only.

A. LOW LUBRICATING OIL PRESSURE

1. If oil pressure drops below 20 psi, but remains above 7 psi when the Throttle Handle is in the 5th to 8th notches; and the Engine Control Switch is in "6" or "Run"; the engine will return to idle, the alarm bell will sound and the low lubricating oil pressure green light will light. If the throttle is reduced to 4th notch or below; or the Engine Control Switch of the affected unit is turned to "4"; the alarm will stop and the engine will assume load up to the 4th notch only.
2. If oil pressure drops below 7 psi, the engine shuts down, the alarm sounds and the low lubricating oil green light comes on.

B. GROUND RELAY

1. A ground in the power circuit operates the ground relay to return the engine to idle, sounds the alarm bell and lights the white ground indicating light at the Engine Control Switch. A red indicator will also appear on the ground relay. The ground relay may be seen through a window of the relay box located in the upper right corner of the Control Compartment. If target does not show see: TRACTION MOTOR BLOWERS.
2. To Reset Ground Relay:
   (a) Turn Engine Control Switch to Idle.
   (b) Push in Ground Relay Reset Button.
   (c) Turn Engine Control Switch to Run.
   (d) If Ground Relay stays in with locomotive under power, continue normal operation.
3. If Ground Relay continues to trip:
   (a) The Motor Cutout Switch (if used) may be used to isolate a faulty motor circuit on Motors 2 and 3. For example: reset Ground Relay as outlined in 2 above; turn Motor Cutout Switch to position "2-Out" and reapply power. Follow same procedure for Motor 3.
   (b) In some cases it may be found that the Ground Relay trips when the throttle is advanced to a certain notch position. In M-U operation, the Engine Control Switch of the affected unit may be turned to limit its operation to a notch position below that at which the fault occurs.
   (c) Under extreme emergency conditions; reset Ground Relay as outlined in 2 above, open GROUND RELAY CUTOUT SWITCH in Control Compartment and move locomotive no farther than is necessary observing for smoke or overheating of electrical equipment. If in M-U operation, the unit should be taken "Off the Line."
   (d) Repeated Ground Relay tripping may indicate a traction motor failure. This might result in a locked axle. Check should be made to insure that all wheels turn freely.

C. TRACTION MOTOR BLOWERS

If the traction motor blowers stop the alarm will ring and the Ground Relay-Blowers Stopped light at the Engine Control Switch of affected unit will light.

1. Check Blower Generator circuit breaker.
2. Check Blower Generator Field circuit breaker.
3. If either is tripped the following order MUST be used in resetting:
   (a) Throw both breakers to OFF position.
   (b) Close blower generator breaker.
   (c) Close generator field breaker.

Warning: Never close Blower Generator Field Breaker before closing Blower Generator Breaker.

4. If this does not correct the trouble, check M-G set breaker and reset if tripped.
5. DO NOT operate Diesel unit under power with traction motor blowers stopped.

D. DIESEL ENGINE OVERSPEED

1. The overspeed switch automatically drops out the governor clutch to shut down the Diesel Engine when it reaches a speed of 1110 plus or minus 10 r.p.m.
2. To reset overspeed switch:
   (a) Move Engine Control Switch to Off.
   (b) Push in Overspeed Switch reset button.
   (c) Start engine and move Engine Control Switch to Run, pausing three seconds at each intermediate position. If overspeed switch repeatedly trips on any unit, that unit may be operated at partial load by moving the Engine Control Switch to the intermediate position necessary to to keep it from tripping.

E. HOT ENGINE

1. When engine cooling water temperature reaches 185°F:
   (a) The Hot Engine (red) indicating light will light.
   (b) The alarm bell will sound.
   (c) The engine will return to idle.

F. CRANKCASE EXHAUSTER

1. The Yellow Crankcase Exhauster Light, located below the Engine Control Switch, should be ON continuously to indicate that the Exhauster is running.
2. If light is Out, see that Crankcase Exhauster Breaker

is closed. If breaker is closed and lamp is not burned out, report condition.

G. WHEEL SLIP WARNING

1. A wheel slip relay is connected across traction motors 2 and 3 and another across traction motors 1 and 4. When the relays operate, the Wheel Slip Light and Buzzer will operate and power will be automatically reduced and reapplied. For further information, see WHEEL SLIP.

H. DYNAMIC BRAKE WARNING (If Used).

1. When the dynamic braking limit is exceeded, the following indications are provided:
   (a) The loadmeter pointer will enter the Red zone of the BRAKING scale indicating overload on lead unit.
   (b) The Brake Warning Light and Alarm will operate to indicate overload on the lead unit or any unit in multiple.
   For further information, see DYNAMIC BRAKE OPERATION.

I. BOILER FLAME OUT (If Used)

1. If the steam generator stops, the boiler alarm relay closes and causes the White Flame-Out Light to light and the alarm to sound.

J. JOURNAL BOX HEAT INDICATOR

1. Heat indicators installed in the covers of roller bearing journal boxes emit a pungent odor when journal box temperature reaches 220°F.

X ACCESSORIES

A. CAB HEATER

(a) Located in front of engineman's and fireman's position.
(b) Rheostat switch for controlling heater fan is located on Gauge Panel at each position.
(c) Hot water inlet and outlet valves to each heater are located in the nose compartment.

B. STEAM GENERATOR (If Used)
Consult manufacturer's operating instructions.

C. TRAIN CONTROL (If Used)
Consult manufacturer's operating instructions.

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